IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appellant: Qinbai FAN

Serial No.: 10/642,852

Filing Date: 18 August 2003

Title: DIRECT METHANOL FUEL CELL ELECTRODE CATALYST

Group No.: 1745

Examiner: Chu, Helen Ok

APPELLANT'S BRIEF ON APPEAL

Commissioner for Patents
Alexandria, VA 22313-1450

Dear Sir:

This is an appeal of the final Office Action mailed 31 December 2007 whereby all of the claims on appeal have been twice rejected. A Notice of Appeal from the Examiner to the Board of Patent Appeals and Interferences was filed by Certificate of Mailing on 16 January 2008.

REAL PARTY IN INTEREST

The real party in interest in the subject U.S. patent application is Gas Technology Institute, an Illinois not-for-profit organization, having its principal office and place of business at 1700 South Mount Prospect Road, Des Plaines, Illinois,

I hereby certify that this correspondence (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on

29 January 2008

29 Jan 2008
Date

Mark R. [illegible]
Signature

60025 as evidenced by an Assignment from the inventor executed 15 August 2003 and recorded in the U.S. Patent and Trademark Office on 18 August 2003 at Reel 014411, Frame 0057.

RELATED APPEALS AND INTERFERENCES

There are no other Appeals or Interferences known to Appellant, Appellant's legal representative or Assignee, which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending Appeal.

STATUS OF CLAIMS

Claims 1-14 and 40, all of which stand rejected, are currently pending; Claims 15-39 have been withdrawn from consideration. This Appeal is taken from the decision of Examiner Chu, mailed 31 December 2007, in which Claims 1-14 and 40, inclusive, all of the claims pending in the subject application, were finally rejected. Accordingly, Appellant now appeals Claims 1-14 and 40, inclusive.

STATUS OF AMENDMENTS

No Amendment After Final Rejection has been filed in this case responsive to the final Office Action from which this Appeal is taken.

SUMMARY OF CLAIMED SUBJECT MATTER

The invention claimed by Appellant is a fuel cell comprising an anode electrode, a cathode electrode and a proton exchange membrane electrolyte disposed

there between (Page 5, lines 7-17). An anode catalyst layer is disposed on the electrolyte facing surface of the anode electrode or the anode electrode facing surface of the electrolyte (Page 5, lines 17-19). The anode catalyst layer comprises a proton conductive material and an electron conductive material substantially uniformly dispersed throughout the catalyst layer (Page 6, lines 3-5). At least one of the proton conductive material and the electron conductive material comprises lignin (Page 6, lines 3-10; Page 12, lines 1-4). In accordance with one embodiment of this invention, the lignin may be in the form of ligno-sulfonic acid (Page 11, lines 10-12). In accordance with an alternative embodiment of this invention, the lignin is part of a grafted polymer, e.g. polyaniline grafted to lignin (Page 12, lines 1-4). In accordance with one embodiment, the fuel cell is a direct methanol fuel cell (Page 5, lines 11-14).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The first ground of rejection to be reviewed on appeal is whether Claims 1-14 and 40 are unpatentable under 35 U.S.C. 103(a) in view of Srinivas, U.S. Patent Publication No. 2004/0110051 A1 in view of Tripathy et al., U.S. Patent Publication No. 2002/0183470 A1.

ARGUMENT

FIRST GROUND OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-14 and 40 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivas, U.S. Patent Publication No. 2004/0110051 A1 (hereinafter "the Srinivas publication") in view of Tripathy et al., U.S. Patent Publication No. 2002/0183470 A1 (hereinafter "the Tripathy et al. publication"). The Srinivas publication teaches a composition comprising particulate carbonaceous material and a sulfonated conducting polymer containing hetero atoms. Devices utilizing the composition, which may include a metal, include supported electrocatalysts, membrane electrode assemblies and fuel cells. However, *the Srinivas publication neither teaches nor suggests an anode catalyst comprising lignin* as claimed by Appellant, a fact acknowledged by the Examiner.

The Tripathy et al. publication teaches a method for polymerization of aromatic monomers using derivatives of hematin including assembled hematin. In one embodiment, the polymerization is carried out in the presence of a template, along which aromatic monomers align. Assembled hematin includes alternating layers of hematin and a polyelectrolyte, which are deposited on an electrically charged substrate (Abstract). The Tripathy et al. publication also teaches the use of electrically conductive polymers in a variety of electronic devices including electro-chromic

devices, light-emitting diodes, electrostatic discharge protection, and light weight batteries (Paragraph [0003]). *Nowhere does the Tripathy et al. publication teach the use of electrically conductive polymers comprising lignin in fuel cells.* In addition, the Tripathy et al. publication also teaches a method for producing lignosulfonate-Pani complex using hematin (Paragraph [0069]). *Nowhere does the Tripathy et al. publication teach or suggest the use of a lignosulfonate-Pani complex as part of an anode catalyst layer which is both proton and electron conductive employed in a fuel cell as claimed by Appellant.* Appellant further respectfully urges that the Tripathy et al. publication does not teach or suggest the use of a lignosulfonate-Pani complex as a component of a proton conductive material in accordance with certain embodiments of the invention claimed by Appellant. Thus, Appellant respectfully urges that it is mere conjecture on the part of the Examiner as to the suitability of a lignosulfonate-Pani complex for use in the anode catalyst layer of a fuel cell as claimed by Appellant.

The Examiner states:

> "In regard to claims 1-11, 40, the Srinivas reference discloses a fuel cell with an anode catalyst layer comprising a proton conductive material made of sulfonic acid (Paragraph 22). The Srinivas reference discloses a grafted sulfonated polyaniline and a polypyrrole ionomer that is electrically conductive and dispersed throughout a carbon support in fuel cell catalysts (Paragraph 41 and Paragraph 30), however, the

> Srinivas reference does not disclose a material comprising lignin. The Tripathy et al. reference discloses the use of another form of polyaniline, or more specifically, polyaniline-lignin sulfonate complexes (Paragraph 25) which are used as catalyst disposed on electrically charged substrates (Abstract) in lightweight battery (Paragraph 3). The Tripathy reference further disclose (sic) these polyaniline-lignin sulfonate complexes are water soluble virtually eliminating the need for toxic reagents and solvents, and thus creating an environmentally friendly synthesis (Paragraph 14), therefore it would have been obvious to one of ordinary skill to place catalyst such as polyaniline-lignin sulfonate complexes disclosed by Tripathy into another electrochemical device such as the fuel cell; the fuel cell utilizes a sulfonated polyaniline catalyst layer as disclosed by Srinivas in order to create a light weight electrochemical cell without environmental hazards. It is well known in the art that a PEM fuel cell and battery are electrochemical devices have (sic) anodes, cathodes and a proton exchange membrane electrolyte. The PEM fuel cell and battery are therefore functional equivalence (sic). The substitution of known equivalent structures involves only ordinary skill in the art."

That is, according to the Examiner, because batteries and PEM fuel cells are both electrochemical devices having anodes, cathodes and proton exchange membrane electrolytes, batteries and PEM fuel cells are functionally equivalent. Thus, the Examiner argues that teachings with respect to batteries (as set forth in the Tripathy et al. publication) are applicable to PEM fuel cells and, thus, the invention claimed by Appellant involves nothing more than ordinary skill in the art. Appellant respectfully disagrees.

Appellant respectfully urges that *fuel cells and batteries are not functional equivalents as asserted by the Examiner*. MPEP § 2144.06 states:

> "In order to rely on equivalence as a rationale supporting an obviousness rejection, *the equivalency must be recognized in the prior art, and cannot be based on applicant's disclosure or the mere fact that the components at issue are functional or mechanical equivalents* (emphasis added)."

Thus, Appellant respectfully urges that *merely because batteries and PEM fuel cells both may have anodes, cathodes, and proton exchange membrane electrolytes does not make batteries and PEM fuel cells functional equivalents*. Appellant respectfully urges that a fuel cell, although having components similar to those of a typical battery, differs in several respects, a fact known to those skilled in the art and expressed in the prior art. For one thing, it is well known to those skilled in the art that *a battery is an energy storage device*. The maximum energy available from a battery is determined by the amount of chemical reactant stored within the battery itself. The battery will cease to produce electrical energy when the chemical reactants are consumed (i.e. when the battery is discharged). In a secondary battery, the reactants are regenerated by recharging, which involves putting energy into the battery from an external source. In direct contrast thereto, it is also well known to those skilled in the art that *a fuel cell is an energy conversion device* that theoretically has the capability of producing electrical energy for as long as the fuel and oxidant are supplied to the electrodes. In

reality, degradation, primarily corrosion, or malfunction of components limits the practical operating life of fuel cells. Thus, the electrochemical environment as well as the operating conditions of a battery *are substantially different* from the electrochemical environment and operating conditions of a fuel cell. As a result, to the extent that batteries may use catalytic electrodes, longevity of the catalyst is not an issue because the life expectancy of batteries is very limited. In contrast thereto, the longevity of a catalyst in a continuously operating fuel cell having potentially unlimited life expectancy is a critical issue. In addition, in a fuel cell, the electrodes are used to convert a fuel, such as hydrogen or methanol, to electricity and, thus, must be able to perform this function. In contrast thereto, batteries do not convert fuels to electricity and, indeed, do not have the means for such conversion. Thus, the function of the electrodes of a battery is very different from the function of the electrodes of a fuel cell. Given these differences in functionality between a battery and a fuel cell, Appellant respectfully urges that teachings relating to materials suitable for use in battery electrodes are not readily applicable to fuel cell electrodes and the materials suitable for use therein.

Appellant further understands the Examiner's argument to be that because the Srinivas publication teaches the use of sulfonated conducting polymer-grafted carbons in fuel cells employing conducting polymers such as sulfonated

polyaniline, and because the Tripathy et al. publication teaches an electrically conductive material which is a lignin sulfonate polyaniline complex (Paragraph [0069], it would be obvious to one of ordinary skill in the art at the time of the invention to use the material of the Tripathy et al. publication in a fuel cell as claimed by Appellant. The Examiner states

> "The anodes of both fuel cell and battery require conducting polymers and therefore it would have been obvious to one of ordinary skill in the art to interchange the two materials for the same purposes."

The only motivation articulated by the Examiner as understood by Appellant is that the material of the Tripathy et al. publication is electrically conductive and fuel cells employ electrically conductive materials. Appellant respectfully urges that the motivation as articulated by the Examiner ignores the presence of a component in the polymer of the Tripathy et al. publication, i.e. lignin, which, until the invention of Appellant, has never been used in a fuel cell. Thus, the Examiner is asserting that any material having some compositional component of known fuel cells which is electrically conductive is suitable for use in a fuel cell, including direct methanol fuel cells as claimed by Appellant, and such materials provide the improvements exhibited by the fuel cells claimed in the subject application. That is, based upon the motivation for combining the teachings of the Srinivas and Tripathy et al. publications proffered by the Examiner, any sulfonated polymer that is electrically conductive, regardless of

any additional elements or compounds which form the polymer, is suitable for use in the anode catalyst of a fuel cell. Appellant respectfully disagrees.

Appellant respectfully urges that fuel cell performance is the true measure of the suitability of a material for use in a fuel cell, not merely the fact that the material in question happens to be electronically conductive. Thus, while the prior art relied upon by the Examiner for rejection of the subject application clearly establishes that sulfonated polyaniline is suitable for use as an electrode catalyst, none of the prior art teaches or suggests that the grafting of lignin, a material which, prior to the invention claimed by Appellant, has not been used in the anode catalyst of a fuel cell, to a sulfonated polyaniline polymer will result in an electrically conductive material suitable for use *under the operating conditions of a fuel cell*, including direct methanol fuel cells, *which provides the performance improvements described by Appellant.*

Regarding Claim 40, which claims improvements to a direct methanol fuel cell, the Examiner argues that the type of fuel (i.e. methanol) does not limit the structure of the fuel cell, as all fuel cells have an anode, a cathode, and electrolytes. Appellant respectfully disagrees. Appellant respectfully urges that, while it may be true that all fuel cells have an anode, a cathode and an electrolyte, part of the structure of the fuel cell is the materials used to make the fuel cell components, which, in turn,

is dictated by the type of fuel cell as well as the fuel employed in the fuel cell. For example, the materials used to make the components of a proton exchange membrane fuel cell, which typically operates at a temperature of less than about 100°C, would not be suitable for use in a solid oxide fuel cell which operates at temperatures typically greater than about 700°C.

Similarly, the materials used to make the fuel cell components are dictated in part by the fuel used to power the fuel cell. For example, fuel cells typically run on hydrogen in which hydrogen gas is fed to the anode electrode. In some cases, the hydrogen is produced external to the fuel cell and fed directly to the anode electrode of the fuel cell. In other cases, a fuel gas, such as methane, may be introduced into the fuel cell where it is reformed to produce hydrogen and CO_2 which is then fed to the anode electrode. In still other cases, a liquid fuel, such as methanol, is fed directly to the anode electrode of the fuel cell (i.e. direct methanol fuel cells) where it undergoes oxidation at the anode catalyst surface to produce CO_2, protons, and electrons. One of the problems with direct methanol fuel cells as discussed at Page 10, lines 1-16 of the specification of the subject application is the tendency of the methanol molecules also to pass through the electrolyte membrane and react with oxygen at the cathode side, a problem which does not exist with hydrogen fueled fuel cells. Thus, direct methanol fuel cells require fuel cell components comprising

materials, such as the materials claimed by Appellant, to inhibit or prevent this methanol crossover. Such materials are not required by hydrogen-fueled fuel cells. Accordingly, Appellant respectfully urges, contrary to the assertion by the Examiner, that the structure of a fuel cell, specifically the materials used to produce the fuel cell components, is affected by the type of fuel used to fuel the fuel cell.

Claim 14 of the subject application states:

> "A fuel cell in accordance with Claim 1, wherein said electron conductive material comprises in a range of about 5% by weight to about 20% by weight of said anode catalyst layer."

The Examiner argues that this limitation is met by the teachings of paragraph [0136] of the Srinivas publication, which discloses the sulfonated group per monomer unit on the polymer ranges from 0.2-2.9. Appellant respectfully urges that nothing in the recitation of the Srinivas publication cited by the Examiner teaches a fuel cell having an anode catalyst layer in which the electron conductive material comprises in the range of about 5% to about 20% as claimed by Appellant.

In the final Office Action, the Examiner cited a new, *undated* prior art reference which the Examiner argues teaches the use of polyaniline-lignin sulfonate complexes in a fuel cell. Specifically, the Examiner states:

> "As evidence by Sigma Aldrich, discloses a broad teaching of polyaniline are conducting polymers (upper

> left-hand corner) in which can be used in both fuel cell and battery (right tab)." (sic)

The reference is Page 153 from an internet catalog of Sigma-Aldrich Company (hereinafter "the Sigma-Aldrich reference"). Appellant respectfully urges that, not only is the reference not a proper prior art reference, but also it neither teaches nor suggests the use of polyaniline-lignin sulfonate complexes in a fuel cell as argued by the Examiner.

As previously stated, the newly cited Sigma-Aldrich reference cited by the Examiner in support of the rejection of the subject application is an *undated reference* taken from the *Internet* catalog of Sigma-Aldrich Company. The Examiner argues that the undated reference is proper under MPEP § 2124 **Exception to the Rule That the Critical Reference Date Must Precede the Filing Date**. The Examiner states:

> "That is, in certain circumstances, references cited to show a universal fact need not be available as prior art before applicant's filing date. In re Wilson, 311 F.2d 266, 135 USPQ 442 (CCPA 1962). Such facts include the characteristics and properties of a material or a scientific truism."

Thus, the Examiner argues that the reference is suitable for showing a "universal fact," namely that polyaniline has the characteristic and property of being conductive and that it can be used in a fuel cell. Appellant respectfully urges that *neither the*

existence of a material composition nor the usages of the material composition, both of which are at issue in the subject application, are or can be considered to be universal facts. In addition, the fact that a known material may have certain known characteristics and properties does not mean that uses of the material are universal facts. After all, new (and patentable) applications of known materials are created all the time. Accordingly, Appellant respectfully urges that the Sigma-Aldrich reference is not a reference which falls within the exception of MPEP § 2124 and, thus, cannot be cited in support of the rejection of the subject application.

In addition, MPEP § 2128 also states under the section entitled "Date of Availability" that

> "Prior art disclosures on the Internet or on an online database are considered to be publically available as of the date the item was publically posted. If the publication does not include a publication date (or retrieval date), it cannot be relied upon as prior art under 35 U.S.C. 102(a) or (b)."

Accordingly, Appellant respectfully urges that *the Sigma-Aldrich reference clearly is an undated Internet disclosure and, thus, in accordance with this section of the MPEP, is not a proper reference for rejection of the subject application.*

Even if the Sigma-Aldrich reference were a proper reference, Appellant respectfully urges that the Sigma-Aldrich reference clearly does not teach or suggest the use of polyaniline-lignin sulfonate complexes in the anode catalyst layer of a fuel

cell as in the invention claimed by Appellant. In particular, Appellant respectfully urges that disposition of the reference page in a section of a catalog labeled "Fuel Cell/Battery Materials" does not mean that the materials listed therein are suitable for both fuel cell and battery applications. In addition, the Sigma-Aldrich reference explicitly states that polyaniline (emeraldine salt) is *"an additive in polymer blends and liquid dispersions for electromagnetic shielding, charge dissipation, electrodes, batteries and sensors,"* a list from which *fuel cells is notably absent.* Nowhere does the Sigma-Aldrich reference explicitly teach or suggest suitability of the material for use in fuel cells.

Accordingly, for the reasons set forth herein above, Appellant respectfully urges that the Srinivas publication and the Tripathy et al. publication, alone or in combination, do not render Appellant's claimed invention obvious in the manner required by 35 U.S.C. 103(a).

SUMMARY OF ARGUMENTS

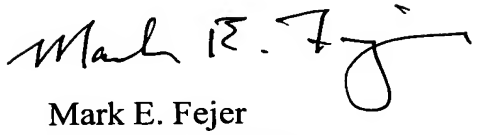
The crux of the invention claimed by Appellant is the use of a proton conductive material and/or electron conductive material comprising lignin as a component of the anode catalyst of a fuel cell. Two references, the Srinivas publication and the Tripathy et al. publication, have been combined by the Examiner for rejection of the subject application on the basis of obviousness. A third, undated,

reference, while not specifically relied upon by the Examiner for rejection of the subject application, has nevertheless been cited by the Examiner in support of the rejection of the subject application. The Srinivas publication teaches a composition comprising particulate carbonaceous material and a sulfonated conducting polymer containing hetero atoms for use in supported electrocatalysts, membrane electrode assemblies and fuel cells. The Tripathy et al. publication teaches the use of electrically conductive polymers in a variety of electronic devices including electrochromic devices, light-emitting diodes, electrostatic discharge protection, and light weight batteries, as well as the use of a lignosulfonate-Pani complex as a component of an electron conductive material. Appellant respectfully urges that the totality of the teachings of the prior art relied upon by the Examiner for rejection of the subject application does not, in fact, teach or suggest the invention claimed by Appellant and, thus, does not render Appellant's claimed invention obvious.

Accordingly, Appellant respectfully requests that the final rejection by the Examiner be reversed.

The Commissioner is hereby authorized to charge the fee for the filing of Appellant's Brief based upon small entity status to Deposit Account 502045.

Respectfully submitted,



Mark E. Fejer
Regis. No. 34,817

Gas Technology Institute
1700 South Mount Prospect Road
Des Plaines, Illinois 60018
TEL (847) 768-0832; FAX (847) 768-0802

CLAIMS APPENDIX

1. In a fuel cell comprising an anode electrode, a cathode electrode and a proton exchange membrane electrolyte disposed there between, the improvement comprising:

an anode catalyst layer disposed on one of an electrolyte facing surface of said anode electrode and an anode electrode facing surface of said electrolyte, said anode catalyst layer comprising a proton conductive material and an electron conductive material substantially uniformly dispersed throughout said catalyst layer, at least one of said proton conductive material and said electron conductive material comprising lignin.

2. A fuel cell in accordance with Claim 1, wherein said proton conductive material comprises a derivative of an acid selected from the group consisting of sulfuric acid, phosphoric acid and mixtures thereof.

3. A fuel cell in accordance with Claim 2, wherein said derivative is selected from the group consisting of sulfonates, phosphonates, sulfonic acids, phosphonic acids and mixtures thereof.

4. A fuel cell in accordance with Claim 3, wherein said proton conductive material is selected from the group consisting of ligno-sulfonic acid, *para*-toluene sulfonic acid and mixtures thereof.

5. A fuel cell in accordance with Claim 1, wherein said electron conductive material comprises at least one electropolymerized ionomer.

6. A fuel cell in accordance with Claim 5, wherein said ionomer is selected from the group consisting of aniline, pyrrole, azulene and mixtures thereof.

7. A fuel cell in accordance with Claim 1, wherein said electron conductive material comprises an ionomer selected from the group consisting of aniline, pyrrole, azulene and mixtures thereof.

8. A fuel cell in accordance with Claim 1, wherein said electron conductive material comprises a grafted polymer.

9. A fuel cell in accordance with Claim 8, wherein said grafted polymer comprises polyaniline grafted to said lignin.

10. A fuel cell in accordance with Claim 1, wherein said electron conductive material is grafted with said proton conductive material.

11. A fuel cell in accordance with Claim 1, wherein said electron conductive material is at least one of sulfonated and phosphonated.

12. A fuel cell in accordance with Claim 1, wherein said proton exchange membrane electrolyte has a thickness of less than about 4 mils.

13. A fuel cell in accordance with Claim 1, wherein said anode catalyst layer comprises a PtRu catalyst material in an amount of less than about 5 mg/cm^2.

14. A fuel cell in accordance with Claim 1, wherein said electron conductive material comprises in a range of about 5% by weight to about 20% by weight of said anode catalyst layer.

40. In a direct methanol fuel cell comprising an anode electrode, a cathode electrode and a proton exchange membrane electrolyte disposed there between, the improvement comprising:

an anode catalyst layer disposed on one of an electrolyte facing surface of said anode electrode and an anode electrode facing surface of said electrolyte, said anode catalyst layer comprising a proton conductive material and an electron conductive material substantially uniformly dispersed throughout said catalyst layer, at least one of said proton conductive material and said electron conductive material comprising lignin.

EVIDENCE APPENDIX

None.

RELATED PROCEEDINGS APPENDIX

None.